Biodiversity in the Western Ghats - A Study with Reference to Moths (Lepidoptera: Heterocera) in the Silent Valley National Park, India)

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Abstract: Insect species diversity with reference to moths was studied in representative forest habitats (viz., disturbed but well regenerating and relatively undisturbed) in the Silent Valley National Park. Preliminary data suggested rich species diversity in well regenerating forests (3.42 & 1.9) as compared to those subject to disturbances like incidence of fire (0.43). Maximum number of moths collected belonged to the families Pyralidae, Noctuidae, Geometridae and Arctiidae. Some families like Lasiocampidae, Bombycidae and Gelechidae were only poorly represented. In general, the fauna bears a close resemblance to that of Sri Lanka although it is characterised by the presence of several endemic species having affinities with the Malayan elements. Altogether 318 species of moths belonging to 19 families were recorded in this study.

Key words: Lepidoptera, Heterocera, biodiversity, fauna, moths, Silent Valley National Park

INTRODUCTION

The tropical rain forests resulting from about 60 million years of evolution, are by far the most stable and sensitive ecosystems as compared to the temperate forests which are of comparatively recent origin. Because of its complex nature, any disturbance in the habitat is likely to affect the delicate balance existing between its various components. Man-induced changes leading to modifications in the land, water, flora and fauna are among the major factors which upset this balance. As a result of disturbances in the biome, many species particularly the insects, become extinct. Since most of the tropical rainforests are located in under-developed or developing countries, lack of adequate scientific expertise is a major constraint in undertaking ecological studies in order to develop sound management strategies. As a result, the disappearance of many species remain undocumented even before establishing their economic importance. Therefore there is an urgent need to study the fauna in these regions (Wells et al., 1983).

The Silent Valley National Park is a typical humid tropical rain forest in the Kerala part of Western Ghats and forms the core area of the Nilgiri Biosphere Reserve (Fig. 1). It is situated on a plateau about 1000 m above mean sea level and covers an area of 9000 ha. Because of climatic, edaphic and altitudinal gradients, the forests of Silent Valley exhibits considerable variations in the floristic composition, physiognomy etc. Four types of vegetations are encountered viz., (a) west-coast tropical evergreen forests (b) subtropical broad-leaved hill forests, (c) montane wet temperate forests and (d) grasslands.

Our knowledge on the insect fauna of Indian forests is largely based on earlier studies by pioneer workers like Hampson, (1896-1898) Although a series of revisionary studies have been subsequently carried out from different geographical regions, no exhaustive survey has so far been carried out specifically from the various forests. This is particularly true with regard to the Western Ghats region which is noted for its richness in biodiversity.

Among insects, the moths belonging to Lepidoptera are economically very important as the primary herbivores in the forest ecosystem. They are diverse in their habits and are adapted
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to a variety of conditions. Being highly sensitive to changes in the environment, they are easily affected by even relatively minor perturbations in the habitat so much so they have been considered as indicators of environmental quality (Kosenberg et al., 1986).

**Materials and Methods**

The moths were collected by using a modified Pennsylvanian-type light trap operated by a 6 V battery, with an automatic switching device to facilitate self operation of the trap in the deep forests at specified timings (Fig 2). An 8 watt UV tube was used in the trap for illumination. The trap was set up on a stand, about 1.2 m in height, on the ground in small forest clearings and the trap was operated overnight on all days (from 6 PM to 6 AM on the next day).

Insect diversity: In order to study the faunal diversity, regular sampling was carried out in four locations - 2 areas at Campsite and one each at Poochappara and Neelikkal within the Sanctuary. The insects collected on each night were sorted out into species and their numbers recorded. The first locality (Campsite, 1st area) represented a well regenerating forest which was subject to logging operations in the past. The second area at the Campsite was similar to the first but was subject to fire in the past. The third and fourth localities represented relatively undisturbed forest types. At each location monthly sampling was carried out for 5 successive days, serially from plot 1 to plot 4, for a period of 5 months. In addition to this, occasional sampling of fauna was carried out during visits to the other parts of the sanctuary.

The insects collected in this study were identified by reference to literature or by referring to the International Institute of Entomology, London.

Data analysis: For calculating the diversity index for the various localities, Shannon-weiner formula was used:

\[
\text{Diversity index } (H^1) = - \sum_{i} P_i \ln (P_i)
\]

where \( P_i \) is the proportion of the 'ith' species in the community, 'S' is the total number of species and \( \ln \) is the log with base "e" (natural logarithm) Pielou, 1975).

In order to assess the overall similarity of different localities with respect to species diversity, the index of similarity (IS) was also worked out. A modified version of Jaccard's formula as suggested by Sorenson (1948) was used. According to this,

\[
\text{the index of similarity } (IS) = \frac{2C x 100}{(A + B)}
\]

where

- \( c \) = number of common species in two 'releves'.
- \( A \) = total number of species in a Plot and
- \( B \) = total number of species in another Plot.

**Results**

Altogether 318 species of moths belonging to 19 families could be collected and identified (Appendix). The families Geometridae, Noctuidae and Pyralidae contained maximum number of species recorded in this study.

Species diversity: The number of insects collected from the various Plots are given in Table 1. The highest number of insects collected was from Plot 1 and lowest from Plot 4 with the species diversity index ranging from 3.42 in Plot 1 to 0.43 in Plots 3 and 4 (Table 2). Although Plot 2 was adjacent to Plot 1, it registered a low value as compared to Plot 1 and this was attributed to the incidence of fire in the former in the previous years. However, with regard to Plots 3 and 4 where the structural quality of flora was far superior compared to the other Plots, the values obtained were quite low. The exact reasons for the low diversity in these Plots are not certain. Probably the influence of seasons (viz. full moon, new moon etc.) or the inappropriateness of sampling sites in these areas could have affected the trap catches. The influence of the above factors on trap catches could not be evaluated in this study since collections were made only for a short period of 5 months from January to May 1989.
Table 1. Number and percentage of species in each family collected from the study Plots (% given in brackets)

<table>
<thead>
<tr>
<th>Families</th>
<th>Plot I</th>
<th>Plot II</th>
<th>Plot III</th>
<th>Plot IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyralidae</td>
<td>26 (21.14)</td>
<td>21 (25.30)</td>
<td>26 (32.13)</td>
<td>12 (30.00)</td>
<td>85</td>
</tr>
<tr>
<td>Geometridae</td>
<td>21 (17.07)</td>
<td>11 (13.25)</td>
<td>14 (17.28)</td>
<td>11 (27.50)</td>
<td>57</td>
</tr>
<tr>
<td>Drepanidae</td>
<td>1 (1.20)</td>
<td></td>
<td>1 (1.23)</td>
<td>1 (2.50)</td>
<td>4</td>
</tr>
<tr>
<td>Epiplemidae</td>
<td>2 (2.41)</td>
<td></td>
<td>1 (1.23)</td>
<td>1 (2.50)</td>
<td>2</td>
</tr>
<tr>
<td>Notodontidae</td>
<td></td>
<td>8 (9.64)</td>
<td>1 (1.23)</td>
<td>3 (7.50)</td>
<td>16</td>
</tr>
<tr>
<td>Lymantriidae</td>
<td>4 (3.25)</td>
<td>8 (9.64)</td>
<td>1 (1.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arctiidae</td>
<td>22 (17.88)</td>
<td>15 (18.07)</td>
<td>11 (13.58)</td>
<td>9 (22.50)</td>
<td>57</td>
</tr>
<tr>
<td>Noctuidae</td>
<td>36 (29.27)</td>
<td>23 (27.73)</td>
<td>24 (29.63)</td>
<td>3 (7.50)</td>
<td>86</td>
</tr>
<tr>
<td>Sphingidae</td>
<td>9 (7.32)</td>
<td>1 (1.20)</td>
<td>1 (1.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lasiocampidae</td>
<td>2 (1.63)</td>
<td>1 (1.20)</td>
<td>1 (1.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturniidae</td>
<td>3 (2.44)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cossidae</td>
<td></td>
<td></td>
<td></td>
<td>1 (1.23)</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>123</td>
<td>83</td>
<td>81</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

In order to judge whether the insects collected in the samplings fully represented the moth fauna, a collector's curve was prepared by plotting the number of insects collected up to the i-th period (i=1, 2, 3, 4, 5 month; pielou, 1974, p. 288). The curves (Fig. 3) were found to rise continuously in all the localities indicating that the sampling was not sufficient and that further collections are necessary for getting a more complete estimate of the faunal diversity of these areas.

Table 2. Species diversity index for the four plots sampled

<table>
<thead>
<tr>
<th>Plot No. and Locality</th>
<th>No. of families</th>
<th>No. of species</th>
<th>No. of individuals</th>
<th>Species diversity index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot 1</td>
<td>8</td>
<td>123</td>
<td>580</td>
<td>3.42</td>
</tr>
<tr>
<td>Plot 2</td>
<td>9</td>
<td>83</td>
<td>319</td>
<td>1.9</td>
</tr>
<tr>
<td>Plot 3</td>
<td>10</td>
<td>81</td>
<td>327</td>
<td>0.43</td>
</tr>
<tr>
<td>Plot 4</td>
<td>7</td>
<td>40</td>
<td>180</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Family diversity: The relative abundance of the various groups of moths was another aspect studied. Maximum number of families was recorded in Plot 3 (10; Poochappara) followed by Plot 2 (9; Campsite). Least number recorded was for plot 4 (7; Neelikkal). In all the four Plots, the families Pyralidae, Noctuidae, Geometridae and Arctiidae were the dominant groups (Fig. 4). Certain families like Sphingidae, Lasiocampidae, Saturniidae and Cossidae were very scarce in the trap catches. The representation of certain families in the various Plots was interesting. The family Saturniidae was represented only in Plot 1 and Cossidae in Plot 3. The distribution of some of these families might prove to be of importance in that their occurrence could probably be associated with specialities in the floral composition in a particular habitat.

Table 3. Similarity index values for the four localities studied

<table>
<thead>
<tr>
<th>Similarity index values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot Nos.</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
</tr>
</tbody>
</table>

Faunal affinities and endemism in the fauna: The faunal similarity of the four Plots was studied and the indices of similarity are given in Table 3. The Plots 1, 2 and 3 and more of less same value, compared to that obtained for Plot 4 which was low. The reason for this is not known but could be due to differences in the floral composition. Further studies are needed to ascertain this aspect.

DISCUSSION

The study has indicated that the Heterocera of Silent Valley is rich and diversified. Altho-
Fig. 3. Collector’s curve for Plots I, II, III and IV.
ough collections could be made only for a short period of 5-6 months in a year (due to inaccessibility to this area during the rainy seasons as a result of landslides, tree fall, etc.) altogether 318 species of moths have been recorded. The findings of this study indicate that, well regenerating forests are rich in species diversity (3.42). The adverse effect of disturbance on fauna was also shown by the drastic reduction in the diversity index in fire affected forest patch (1.9). However, the fact that further samplings are necessary, is indicated by the collector's curve, which shows an upward rise. The species diversity indices obtained for the various localities therefore do not actually indicate the exact status of diversity and the values obtained here are of an indicative nature only.

The fauna of Silent Valley bears a close resemblance to that of Sri Lanka, although the latter is characterised by the occurrence of several endemic genera and disjunct species groups which do not have any relatives in S. India (Larsen, 1987). The low land evergreen forests of Silent Valley have a good representation of South Indian species although the forest patches at higher altitudes as well as the sholas contain several species which bear a close resemblance to that of Sundaland although they have developed into distinct races over years of isolation. Holloway (1974) and Larsen (1988) are of the opinion that Indian fauna is one largely formed as a result of displacement by invaders from other regions of the Oriental region, after its separation from Gondwanaland and merger with Asia. Most of the endemic species in the Western Ghats had their origin elsewhere in the Oriental region and are still surviving in isolated habitats. The moths *Loepa sikkima*, *Trabala ganesha*, *Oxyambulyx subocellata*, *Theretra ncessus*, *Macroglossum aquila*, *Tarsolepis rufobrunnea malayana*, *Phalera sundana*, *Cyana perornata*, *Eliema tetragona*, *Oeonisis entella*, *Spilosoma anada*, *Tridrepana fulvata* etc., (Barlow, 1982) are some of the species having Malayan affinities recorded from the Nilgiri Biosphere Reserve. A small fraction of insects are having Palaeartic (*Borbacha sp.*, *Eumelia rosalia*, *Ozarba punctifera*, *Rhodogastria sp.*, *Euproctis bipunctapex*), Australian (*Maceda mansueta*, *Pyrausta Phoenicealis*, *Crocidolomia sp.*), and Ethiopian (*Pingasa ruginaria*, *Britta sp.*, *Sauris* sp.) affinities.

![Fig. 4. Propagation of various major taxonomic groups in four sampling sites](image1)

![Fig. 2. Butterfly operated light trap used for moth sampling.](image2)
diversification and adaptation of the surviving ones, destruction of species is unlikely to generate very much diversity in the rainforests because of its complex structure (Turner, 1984). The occurrence of a rich and diversified fauna in some parts of Nilgiri Biosphere region was largely attributed to the conservation of forests in this region (Larsen, 1987, 1988). Conservation of the natural habitats is very essential for the existence of many species of lepidopterans. The survival of a large number of endemic species in the Silent Valley area warrants frequent monitoring of the ecological processes besides adoption of appropriate conservation strategies in order to safeguard its rich genetic diversity.

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REFERENCES


Appendix - List of moths collected from Silent Valley National Park

<table>
<thead>
<tr>
<th>HETEROCLERA (MOTHS)</th>
<th>DREPANIDAE</th>
<th>TEODOENIA Sp</th>
<th>PHALACRA minorata Walker</th>
<th>TRADUPHENA jutavae Snellen</th>
<th>THYRIDIDAE</th>
<th>BANASIA myrtacea (Drury)</th>
<th>PYRALIDAE</th>
<th>FYNIX hypotrichus (Swinhoe)</th>
<th>PROPHILAUSA pyrostigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Hampson)</td>
<td>Crocidolomia pavanoni (Fabricius)</td>
<td>Callidula dactylargata Ragonot</td>
<td>Ancolomea chrysogaster</td>
<td>Kollar</td>
<td>Musotima javanaetis Hamson</td>
<td>Catulusis blaudiis Walker</td>
<td>Pycnanthemus caerulanus Guenee</td>
<td>Agrotis basilisata Hamson</td>
<td>Aethalix flavibalsalis Guenee</td>
</tr>
<tr>
<td>D. plutusalis Walker</td>
<td>Hyalabathra miniosalis Guenee</td>
<td>Paradomima distorta Moore</td>
<td>Borvodes asialis Guenee</td>
<td>S. quadricomatus Kollar</td>
<td>S. tibialis (Moore)</td>
<td>S. tibialis (Moore)</td>
<td>Agathodes ostentalis Hubner</td>
<td>Agathodes ostentalis Hubner</td>
<td></td>
</tr>
</tbody>
</table>
Amathisia hilaralis Walker
Parnos marina Fabricius
P. marginata Hampson
P. vertumnalis Guenee
Phalerae stalalis Guenee
G. italy Walker
G. histricalis Guenee
G. caesalis Walker
G. hicalor Swinhoe
G. indica Saunders
Phryxetis tyres Cranmer
Eucalia filigeralis Leaderer
E. deunalis Walker
Naoimoe's perspecta Fabricius
N. geometra Guenee
Leucinodes arbolis Guenee
Cordylophora pterophora
Hampson
Pachycentrus laticrinalis Walker
P. crinalis Walker
Euteatia malanidia Walker
Maruca testula Geyer
Filodes jahurchalis (Hubner)
Daula afuralis Walker
Pyruata phoebealis Hubner
Euphrasia caeata (Walker)
Nephotyress artisquamella
Hampson
Epicris alanalis Walker
Hyalosilia leconteella
Ragonot
Etalia zickelkelli Treitschke
Euphroessa' subsarrella Meyrick
Geometridae
Aptycta Sp.
Fascellenia plagula Walker
F. chronura Walker
Gasterocera pannonaria Moore
Cormys pearley Walker
Hyperpera cyanastica
Hampson
Lasiestra hypaphae Hampson
Lasiestra posttulata Walker
L. sp.? subscabia Walker
Busura sp.? suppressaria Guenee
Cleora sp. alienaria Warren
Cleora sp. julia Walker
Cleora sp.
Menophra ' inocui Setz
Eurydypheira sp.
Cateria sp.
Ectopis sp.? breta Swinhoe
Ectopis brynett Walker
Ectopis insolitata Hampson
E. ? boarmaria Guenee
E. incomcansa Walker
Mediasia sp.
Hypomecis polliida Hampson
H. sp. nr. dentigerata Warren
?Hypomecis sp.
Scopula sp.? nr. pulverosa Prout
Scopula sp.
Trimandrus sp.? nelsoni Prout
Ptychophyle tortuata Fabricius
Anityrsegus divisa Walker
Anityryseus culex Walker
Petelia sp. of medardaria
Herrich-Schaffer group
Hypochrysia festivaria Fabriciua
H. paixia Walker
H. sp.? abstractor Walker
Subaria cucumisulae Moore
S. sp. nr. rendeuri Fabricius
S. incutait Wit.
Semiontta sp. prob. nera
Semiontta sp. triangularia Hampson
S. ferruginata Moore
S. rubifasciata Walker
S. grunaria Walker
Semiontta sp.
Ourapteryx marginata Hampson
Thysania exopterata Butler
Heterosteginae subsectoriella Walker
Heterosteginae sp.
Borbonia sp.? paradaria Guenee
Lomographa sp.? simplicia Walker
Abraxas sp. of paniaria Swinhoe group
A. xylata Scop.
A. sp. near latocanata Hampson
Scordis rectelli Warren
Plutodes sp.? discigeria Butler
Plutodes sp.
Eiptetora subapicalis
Hampson
E. dissacta Moore
Diaspida quadriaria Guenee
Vloosnema partita Walker
V. inplunata Moore
Archichalcos cristata Warren
Pachyodes fujetes Felder
Hemithrea sp. grammata
Hampson
Cominatae indicaria Guenee
C. integratae Hampson
Neomia cariniformis Butler
Pisaura marginaria Guenee
P. chloris Cramer
Eumeilia rosatal Stoll
Sauris ap.
Elpho sp.
Pulinaea susandava Walker
Xunhorhoe mulida Fleder
Callidulidae
Closeres catamites Hubner
Uranidae
Psedomocisma sp.
Epileneidae
Epilene sp.? maza Butler
Drades unicauda Dudgeon
D. leucocera Hampson
D. theleus Guenee
Epilenea albula Hampson
Noctuidae
Neoluxena dominia Cramer
Conicia ilicetra Walker
Acharis melanura Fabricius
Euthelia serrula Cramer
Callipristis rutilus Walker
Percina umbria Guenee
Hyrena? subnuda Bethune-Baker
Paracatena latimurra Warren
Eurinia flavida Felder
Macaia mactansu Walker
Labanda fasciata Walker
Nyctelica grisae Hampson
Blenina in seta Dalman
M. in seta Moore
Lophoptera illucida Walker
Hadenna sp.? pronusa Moore
Rhynchina curvilinea Hampson
Britus patalis Walker
Pseudogrytus pervera Walker
Eunorphia marginata Walker
Ozarka sp.? pungentera Walker
Mollantra erelui Moore
Coragathia sempraria Walker
Anomis subulifer Guenee
A. jgina Butler
Timonius quinmaculatus Walker
Nola tinguesis Moore
Lama hauramurata Moore
Jan essential melanopsia Guenee
Sasauna sp.? tenechrisa Moore
Mythicina curvitinae Hampson
M. reversa Moore
M. vitattia Hampson
Mythicina sp.
Tiracula plagula Walker
Atheticus renalis Moore
Conicida ilicetra Walker
Odontodes alea Guenee
Pseudahybra naha Hufner
Xenotrichia albidisima Moore
Madaria (= Plagiectela) sp?
?Plagiectela Hampson
Digama marshallis Guerin
Carer endophila Hampson
Eric eux sp.? inangulata Guenee
Rhesala morealis Walker
Suraba pastula Walker
Hydralodes sp.? prob. nigricalolis Hampson
Thyas honesta Hubner
Rhyma hypermesula (Stoll.)
Elynora materu (Linneaus)
Othreus fullomia (Clerck)
Epipristis lustrata (Fabricius)
Targulla ludatrix (Walker)
Erebus caprimalus
E. hieroglyphica Drury
E. ephesia
Aste sp.
Sporolettera mauretia Boisdal
Maurilia sp.
Hypopilina bonifides Guenee
Bacuna munisestalis Walker
Butracharita variegata Walker
Arthisma scorlalis Moore
Cerynea ustula Hampson
Coreospars insulata Walker
Tegumastes littigium Moschler
Sathriphiles sp.
Oxydes sp.
Ariciliae
Amata extensa Walker
Argina syringa Cramer
A. astrea Drury
Pericallis sp. of ricini Fabricius complex
Eilema rutila Walker
E. sp.? olithiera Walker
Eilema tetragona Walker
?Eilema sp
Eilema sp
Macteasa sp.? nabeula Moore
Nilgiricola sicciana Hampson
Siccia iprana Walker
Cymnathis gosser Guerin
Meneville
Asura metamelas Hampson
A. sp.? olithiera Moore
A. aurata Moore
A. rubricosa Moore
Asura sp.
Eugia sp. of bipunctata Walker complex
Sipillosa sp. ? muna Swinhoe
S. anura Roeke
Sipillosa sp.
Papugena matherana Moore sp.
Papugena hampsoni Swinhoe
Lentysa sp.
Parana splendidus Butler
Ceryx transita Walker
Evessa sp.
Oenomis entella Cramer
Cyna biaurora Walker
C. mualayensis Hampson
Cyna sp.
Rhopalocoria pasturalis Drury
Asota plana Walker
Asota producta Butler
Nyctemera caerulea Cramer
N. adversa Shallev
N. hulius Boisduval
Euromorgia polymena Linn.
Symatris thoracicae Moore.
Lymantridae
Cispiia charmara Swinhoe
Lymapsy sp. probably Karuna Colleman
L. tidara Moore
Arros sp. of plana Walker complex
Redous sp.
Euprotis bipunct supra Hampson
E. fraterna Moore.
E. peronostor Colleman
E. semiaurata Walker
Luaella? colon Hampson
Cispiia charma Swinhoe
Notodontidae
Poliosia aurata Hampson
Bombycidae
Penicillifera sp. prob. apicalis Walker
Tortricidae
Nenomia poeta Meyrick
Olethreutes paragamma Meyrick
Lasiocephala mormo Meyrick
Dactyloglyphia harmonica (Meyrick)
Udea ferrugalis Hubner
Bosra indicator Walker
Thylacoptila paurosema Meyrick
Adoxophyes revoluta Meyrick
Archips sp.
Gelechidae
Dichomeeris sp.
Cossidae
Xyleutes sp.
Zeuzera induca Herrich Schaffer
Phragmataecius impura Hampson
Saturniidae
Argema macenas Doubleday
Attaeus atlas Linnaeus
Loepa sikkima Moore
Lasiocampidae
Cyclophragma sp.
Sphingidae
Acherontia lachesis Fabricius
A. styx. Westw.
Megantonia bp.
Oxyambulyx sp.
Agrius sp.
Hippotion boerhaviae Fabricius
Theretra sp. costeana Moore
Macroglossum aquila Boisduval
Rhagastis sp. ? castor Walker
Acosmeryx shervillii Boisduval
Herse convolvi Linn.